TEMPERATURE AND VAPOUR PRESSURE REGULATION DEVICE FOR A STRUCTURE

This invention relates to a device for regulating the temperature and vapour pressure in a structure. More particularly, it concerns a constructional element, which is provided with ducts for heat regulation purposes, wherein moisture can be drawn into the ducts of the constructional element.

In known construction and building structures the constructional element separating storeys is normally made of concrete, whereas walls may be made of concrete or a plate material. The constructional element commonly extends between the supporting parts of the construction or building structure, and is either cast on site or in the form of ready-made elements. Working with such constructional elements of concrete is resource demanding in separate ways. The use of a heavy material like concrete in the storey-partitioning element means that the dimensions of the supporting elements must be increased. Besides, each level must be given an additional height of at least 30 cm in order to provide space for ducts for the air normally used for heating and/or cooling of rooms in the construction or

building structure. These are all conditions that add to the costs of known structures.

In the cooling of buildings in tropical areas, where the outdoor temperature can be in the order of 45 °C and the relative humidity can be of up to 99 %, it is evident that condensation of air humidity inside the building can be a considerable problem. The desired relative air humidity within buildings in areas of this kind is between 40 and 60 %. Condensation of humidity is also a known problem in refrigerating rooms and freezing rooms.

For the cooling of indoor air it is common to use a cooling plant of the kind in which outdoor air is cooled and blown into the building both to regulate the indoor temperature and to lower the relative humidity of the air. It has proved necessary to lower the air temperature at the outlet of the cooling plant to approximately 7 °C to reduce sufficiently the relative humidity of the air. This condition combined with the amount of cooled air that will have to be supplied to the building in order to carry away the thermal energy conducted in through walls, floors and ceilings, entails relatively high energy consumption.

According to the prior art, in order to reduce the energy consumption to some extent, it is common in the countries where it is permitted, to use so-called return air ventilation. That means that only part, for example 20 %, of the ventilation air supplied to a room is outdoor air, whereas the remaining portion is mixed-in indoor air which only needs cooling corresponding to the temperature increase it has had during its circulation within the building.

It is also known to cool buildings without outdoor air being added.

The method of cooling of this kind according to the prior art is, as mentioned, relatively energy demanding, especially if an acceptable indoor air quality is to be maintained. It can be mentioned that in several countries, including Norway, it is not permitted to use return air ventilation. It is also common that cooling plants of the kind in question emit considerable noise, and that the necessary air flow volume leads to uncomfortable draught.

Norwegian patent application 19982520 discloses a device in a constructional element included in a construction or building structure, in which a constructional element is of such configuration that it comprises a duct system for air. The air ducts of the system run parallel to each other, the constructional element being made up of at least three interconnected layers of corrugated plate material. The layers are oriented in such a way relative to abutting layers that the corrugations of two adjacent layers are perpendicular to each other. The intermediate layer between an upper layer and a lower layer that are essentially horizontal in the position of use of the constructional element, is formed with a number of transversal through holes connecting the air ducts of two adjacent air duct systems. One air duct system can serve as a supply air duct system for heated or cooled air and the other as an evacuating system or return air system.

However, the device according to the Norwegian patent application mentioned is not arranged to deal with moisture from the rooms adjacent to the constructional element.

The invention has as its object to remedy the drawbacks of the prior art.

The object is realized in accordance with the invention through the features specified in the description below and in the following Claims.

A constructional element, for example to be used as a ceiling, storey-partitioning element, floor or wall is formed with air ducts in a corresponding way to that of the constructional element according to the Norwegian patent application 19982520.

The air ducts in the system extend parallel to each other, the constructional element being made up of at least three interconnected layers of corrugated plate material. The layers are oriented in such a way relative to abutting layers that the corrugations of two adjacent layers are perpendicular to each other. The intermediate layer between the two layers that are the external layers in the position of use of the constructional element is formed with a number of transversal through holes connecting the air ducts of two adjacent air duct systems. One air duct system can serve as a supply air duct system for heated or cooled air and the other as an evacuating system or return air system.

In what follows, the external layer facing away from the room which is to be temperature-regulated is referred to as the outer layer, whereas the external layer facing in towards the room which is to be temperature-regulated is referred to as the inner layer.

The inner layer is provided with through openings, by which humidity that has condensed onto the layer or onto an adjacent, preferably porous material can be drawn into the air duct located within.

The constructional element is suitable for use as a heat exchanger element in buildings, for example for residential and industrial purposes, cooling and freezing rooms or in refrigerating and freezing counters.

Depending on the required energy transfer to/from a room, more or fewer of the constructional elements in a building can be formed in accordance with the invention, as the constructional element has a through-flow of air in an essentially closed circuit.

Air, which is conducted in between two abutting layers, flows alternately along and across the corrugations of the layer, which has the effect that an essentially turbulent form of flow arises. A turbulent flow has the effect that a substantial improvement of the heat transfer between gas and layer is achieved compared to laminar flow. In principle, the air flowing in between layers can spread through transversal and longitudinal corrugations over the entire area of the layer.

With cooled air, for example having a temperature of 17 °C, flowing between said layers, said surfaces work as a cooling element and can keep the indoor temperature at a desired level. The air flowing between the layers can flow, for example, in a direction from a cooling unit in the space between the intermediate layer and the outer layer, after which it flows, at one or more points in the portion of the constructional element opposite to the cooling unit, through the intermediate layer and back to the cooling unit in the space between the intermediate layer and the inner layer.

The air is then cooled to a degree corresponding to the heat quantity that has been added to it, after which it is circulated back between the layers. Thus, it is not necessary to cool new outdoor air in order to maintain the cooling effect of the building elements.

Any ventilation air, which, with the use of the invention, does not have to contribute to cooling, can be supplied to the building in a substantial smaller amount compared to the

prior art. Normally it will not be necessary to cool this flow of air.

As the side of the corrugated inner layer of the constructional element which is placed on the side of the constructional element facing the room is perforated, the excess humidity which is supplied to the building, for example together with the ventilation air and settles on the relatively cold inner layer, will be drawn into the cavity between the perforated inner layer and the intermediate layer. The humidity then follows the cooling air to the cooling unit where it condenses and is carried away.

In what follows is described a non-limiting example of a preferred embodiment which is visualized in the accompanying drawings, in which:

Figure 1 shows schematically a sectional plan view II-II of Figure 2 of a building, in which the ceiling, floor and walls are provided with corrugated plates according to the invention;

Figure 2 shows schematically a section I-I of the building of figure 1;

Figure 3 shows a perspective section of the floor of figure 2, in which three corrugated layers lying on top of each other are placed in a covering way over the foundation. The slab of the floor is not shown; and

Figure 4 shows, in a section, an alternative embodiment, in which the constructional element is used as a storey-partitioning element in a building, and in which the walls are also formed by constructional elements according to the invention.

In the drawings the reference numeral 1 identifies a building comprising walls 2, 4, 6, 8, a floor 10 and a ceiling 12. Other necessary structural details like doors and windows are not shown.

The floor 10 and the ceiling 12 are provided with three covering corrugated layers, one above the other, in the form of plates 14, 16 and 18, and 14', 16' and 18', respectively, in which the corrugations of the intermediate plate 16, 16' lie at an approximately right angle relative to the corrugations of the outer plate 14, 14' and the inner plate 18, 18'. The plates 14, 16 and 18, and 14', 16' and 18', respectively, are connected to each other and to the floor 10 and ceiling 12 by means of, for example, glue, screws, dowels or by means of other securing means known in themselves. The interconnected plates 14, 16 and 18 form a constructional element 19 which may be load-bearing. The walls of the building are also provided with a constructional element 19.

A cavity 20, see figure 3, located between the outer plate 14 and the intermediate plate 16, and a cavity 22 located between the intermediate plate 16 and the inner plate 18, are sealingly defined by the walls 2, 4, 6, 8 and basically form a closed cavity each.

A cooling unit 24 of a kind known *per se* is placed on the wall 2 and is arranged to circulate cooled air in the floor 10. The outlet side of the cooling unit 24 is connected to the cavity 20 located between the outer corrugated plate 14 and the intermediate corrugated plate 16 by means of an admission duct 26. Cooled air flows in the cavity 20 like the arrow A shows, see Figure 3, to at least one through opening 28 of the intermediate plate 16 near the wall 6. From the openings 28 the air flows like the arrow B shows, through the cavity 22 back to the cooling unit 24 by a return duct 30. The cooling unit 24, the corrugated plates 14, 16 and 18 of the floor 10, the openings 28 and the ducts 26 and 30 thus

form an in principle closed cooling circuit which is arranged to keep the floor temperature at a desired level.

Correspondingly, the corrugated plates 14', 16' and 18' of the ceiling 12, together with the cooling unit 24' and necessary ducts and openings, form an in principle closed cooling circuit in the ceiling.

Ventilation air is supplied to the building via a blower 32. Excess humidity in the supplied ventilation air will condense onto the coldest surface in the building, being the inner plates 18, 18' by the use of the invention. By providing the inner corrugated plate 18, 18' with perforations 34, the condensed humidity can be drawn into the space 22 and follow the cooling air to the cooling units 24, 24' where the humidity condenses and is drained away. The inner corrugated plate 18 can possibly be replaced by a porous plate, not shown. A volume of air corresponding to the volume of ventilation air flowing in through the perforations 34 flows out into the surroundings from the cooling units 24, 24'.

In an alternative embodiment, see figure 4, constructional elements 19 are dimensioned for, and used as, respectively, the supporting partitioning floors 36 and walls 38, and floor 10.

By the use of the method according to the invention a substantial improvement of the indoor climate is achieved compared to the prior art, while at the same time the reduction in the amount of air that needs to be cooled entails a considerable reduction in the use of energy.

The use of the constructional element 19 in cooling and freezing plants, not shown, will have the effect that there will be an improved environment in the plant.